THE RELATIVE EFFECTIVENESS OF TWO METHODS OF TEACHING BIOLOGY TO TENTH GRADE STUDENTS

A THESIS

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CHAPTER I

INTRODUCTION

Rationale.--All too frequently, discussions of the merits of various methods of teaching seem to generate a considerable amount of heat without producing much light to guide the teacher in the classroom. Proponents of different techniques often base their arguments upon personal and subjective evaluation of their own experiences as students and teachers or build their case on the opinions of others who have reached conclusions in a like manner. While opinions of experienced teachers are invaluable in our efforts to improve instructions, perhaps we should also give due consideration to what research says about the relative effectiveness of the different methods in attaining educational objectives.

If we look back over a period of the past twenty-five years we can see what has happened, in the field of research, to one problem of science teaching, namely, the problem of the relative effectiveness of lecture demonstration versus individual laboratory work. Perhaps it will be well to recall a few of the factors which were present in the science teaching situation at the time when intense interest in these two techniques arose. The end of the nineteenth century and the beginning of the twentieth found the schools faced with the necessity of teaching large number of students, often in large classes. As the schools grew in size and their financial burdens increased, criticism arose concerning the cost of science instruction the cost of equipment, supplies, services facilities, furniture and specialized

rooms. Then, too, there developed a tendency in some schools - particularly the large ones - to simplify the complex administrative problems of making programs by scheduling all subjects for uniform single periods and eliminating double periods for laboratory work. There were also contributing factors from research in the fields of Education. A great enthusiasm for the development of a Science of Education was abroad in the land.

In the consideration of research relative to the effectiveness of lecture demonstration and individual laboratory approaches, it became necessary to define the two methods. The lecture demonstration is the type of approach whereby the instructor conducts a demonstration-experiment. There certainly are great differences in the characteristics of the lecture and demonstration from one instructor to another and from one time to another with the same instructor. The degree of formality, the opportunities provided for questions or comments from students, and the manner and rate of presentation are but a few of the variables. About all that can be said is that science educators appear to have conceived the lecture demonstration to be a more or less continuous oral presentation of information, ideas, and demonstrations made by teachers with little or no active participation by the members of the class, other than their recording of the data and observation of the procedure-process employed by the teacher.

The individual laboratory method of presentation of subject matter is primarily concerned with the performance of experiements, dissections of investigations by students who follow directions in a laboratory guide which are either printed commercially, given on mimeographed sheets, written on the blackboard, or given orally by the instructor.[1]

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[1] Barger, T. M. "Effectiveness of the Individual Laboratory Method in Science Courses," Journal of Chemical Education, Volume 12, pp. 229-32.

It appears that the individual laboratory method of study has always been regarded as the very heart of science teaching and learning. Within recent years this method as applied at the elementary and secondary level and at the other levels of general education has degenerated into something which is laboratory in name only. It does not represent a true laboratory approach at all, in the sense that a laboratory is primarily a problem-solving activity. Further it appears that the use of the usual substitutes for individual laboratory work in general courses, particularly in the form of audi-visual aids and demonstrations, while they are very effective as teaching tools, does not furnish an answer to the laboratory question. This question to be resolved is essentially the problem of how to recognize and motivate really significant problems at the student level, and how to give these practice in solving problems and at the same time enable them to develop an understanding of scientific attitudes and basis of scientific methods.

Surprisingly, little research has been done to test the hypotheses underlying the laboratory vs. the lecture-demonstration methods. Many claims are made in the opinion literature. Hence, it is high time that research be done to test the validity of the hypotheses.

The Evolution of the Problem.---The writer is a teacher of biology of the tenth grade at Oxford Training High School in Oxford, Mississippi. Often, in teaching biology, the writer has felt that her methods have been inadequate because the pupils did not exemplify or achieve to their fullest, and too few of the graduates pursued further study in science fields as a result of instruction. Thus, the writer sought to find ways and means of providing more meaningful instruction.

Contribution and Value of Educational Knowledge, Theory and Practice.--The writer hopes that the finding of this study will have the following values:

1. This study may be of value in that it may assist member of the profession in their search for answers to the many questions revelant to the utilization and improvement of the two methods of teaching biology which are proposed to be studied.
2. This study may furnish information useful to future researchers in clarifying, further, the relative values of lecture demonstrations and individual laboratory methods and thereby help them to discover ways of improving the quality of these methods.
3. This study may reveal facts that substantiate the importance of considerable improvement in experimental design.
4. The study may reveal a need for designing new evaluative techniques and refinement of instruments that are basic to progress in research.

Statement and Definition of Problem.--The problem of this investigation was to determine the relative effectiveness of two methods of classroom instruction, the individual laboratory and the lecture demonstration methods, when they were used in the teaching of general biology to tenth grade students.

Limitations and Scope of the Study.--This study was limited in that it was confined to the total enrollment of the tenth grade of the Oxford Training High School, Oxford, Mississippi 1959-60. It is also limited to the extent that any experimental design provides certain limitations in freedom of movement and operation which may or may not be indicated, but which are

without the context of the study as originally structured.

Purpose of the Study.--The purpose of the study was as follows:

1. To test, by experimentation, the following null hypothesis: There is no difference in the relative effectiveness of the methods, individual laboratory and lecture demonstration, as determined by the criterion of achievement on standardized tests.

Definition of Terms.--In order to effectively understand the methods, procedures and analysis and interpretation of the data, it is necessary to define certain terms:

1. "Individual Laboratory Method" refers to the performance of experiments, dissections or investigations, following directions on a laboratory guide, given on mimeographed sheets, or written on the blackboard, or given orally by the instructor.[1] The individual-laboratory method was the experimental method.
2. "Lecture Demonstration Method" refers to the type of laboratory program whereby the instructor conducts the experiment with data and observations being taken by the students.

Method of Research.--The experimental method of research was used in this study, employing the rotation group technique and administration of teacher made achievement tests to gather the data required to fulfill the expressed purpose of the study.

Experimental Group	Control Group
M_1	M_2

[1] T. M. Baryer, "Effectiveness of the Individual Laboratory Method in Science Courses." Journal of Chemical Education, XII (May, 1935), 229-32.

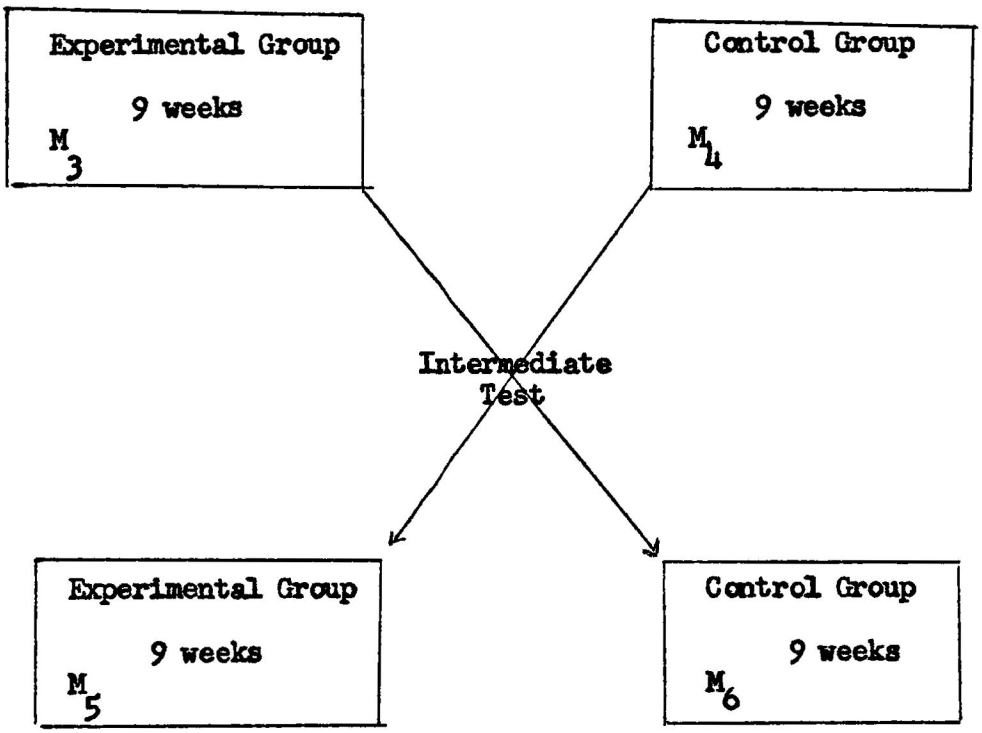

Fig. 1.--Using the Method of Cross-checking of groups. (Diagram showing cross-checking method.)

Locale of the Study.--The locale of this study involved students enrolled in a school in Lafayette County, Mississippi, namely the Oxford Training High School, grade ten. This school is organized on the departmentalized plan. The study was conducted during the 1959-1960 academic year.

Procedural Steps in the Study.--The procedural steps in conducting the research are enumerated below:

1. Permission to conduct the study was requested from the proper school officials.

2. Literature pertinent to this study was reviewed, summarized and is presented in this chapter.
3. The pupils who served as subjects in this study were oriented as to the nature, scope and purpose of this research. These groups were not equated. The two groups as listed in the school's schedule were used.
4. The rotation group method was used as the experimental design. One group of subjects was controlled for the nine weeks while the other group was used as an experimental group for the same period. At the beginning of the tenth week the groups were reversed. That is, the group that was the experimental group became the control group and the group that was the control became the experimental group after rotation.
5. The data derived from this study were treated statistically and in turn assembled in appropriate tables and figures.
6. The statistical analysis and interpretation of the data are predicated upon statistics which follow: (a) Mean, (b) Standard deviation, (c) Standard error of the mean, and (d) Standard error of the difference between the mean.
7. Findings, conclusions, implications, and recommendations derived from the study are presented in Chapter III.

Subjects and Materials.--The subjects and materials used in this study were as follows:

1. The subjects involved in this study consisted of all students enrolled in the tenth grade biology at the Oxford Training High School, Oxford, Mississippi.

2. The instruments used to collect the necessary data were:

    1. The Taxonomy of Educational Objectives (Benjamin S. Bloom, Ed.) Langmans, Green & Co., N. Y. 1956 was surveyed to identify and classify educational goals.
    2. The pamphlet "Let's Build Quality into our Science Tests" - (N. D. T. A., N. E. A. - by Clarence H. Nelson, 1958) was used to develop a format for constructing a high school Biology Examination.
    3. The test items were then selected from "Questions and Problems in Science" (Test Items Folio No. 1 - Paul L. Dressel and Clarence H. Nelson, Ed.) Testing Service, Princeton, N. J. and 3 forms developed consisting of 50 items each.

Review of Literature Related to this Study.--Many studies have been done and much has been written about the relative merits of the lecture-demonstration and individual laboratory methods of teaching science. The accumulated evidence does not conclusively favor one method over the other. Whether one method were to be judged superior to the other would seem to depend upon the objectives sought and the conditions under which the course was taught. It may also be a function of the research design, and the instruments utilized in collecting the data.

It is doubtful that individual laboratory work that follows a cookbook procedure can do much more to achieve behavioral objectives of problem-solving and scientific attitudes than good lecture-demonstrations. On the other hand, if the laboratory is to serve a function for the student, similar to the one it serves for the scientist, it must become a place to solve problems. If this were to be the concept of the science laboratory in the

secondary school, the laboratory would become just as important a facility for teaching science as the basketball court is for teaching young people how to play basketball.

There have been many studies made concerning the relative merits of two opposing techniques of laboratory presentation both in the fields of chemistry and in the field of physics. None of these studies have as yet found any conclusive results as to the superiority of either method. Payne[1] in a study of college freshmen maintained that college freshmen who had studied chemistry by the lecture-demonstration method showed a trend toward greater success on an achievement test than was shown by the students doing individual laboratory work. Fuller[2] in another study attempted to show the greater investive attitude developed by students doing indivisual laboratory work.

Kyte conducted a study to compare the laboratory method of instruction with individual demonstration. From treatment of the data obtained from examinations, the use of the lecture demonstration method was more effective than use of the individual laboratory method alone in the amount of subject matter learned and retained; the use of the new method for review purposes favored significantly the experimental group; when included at the end of a period with a specific unit of work, the individual demonstration was more effective.[3]

Degering and Remnues reported upon the relative effectiveness of individual laboratory work and the lecture-demonstration method in the teaching

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[1] V. F. Payne, "Lecture Demonstration and Individual Laboratory Methods Compared," Journal of Chemical Education, IX (July, 1932), 1277-349.

[2] R. W. Fuller, "Demonstration of Individual Laboratory Work for High Schools," Journal of Chemical Education, XIII (June, 1936), 262-64.

[3] George C. Kyte, "Methods of Teaching" Review of Education Research, XV

of organic chemistry to home economics students. The authors found the lecture demonstration was effective and they argued its adoption in view of the amount of money that would be saved in comparison with the individual laboratory method. A second investigation of the lecture demonstration versus the individual laboratory was conducted by Steen and James and involved the teaching of physics. These authors reported that for high ability students the lecture demonstration method was superior where as students of lesser ability learned more effectively when they were given opportunity for individual laboratory experience. A third study of the relative effectiveness of the lecture demonstration and individual laboratory work was made by Elder in chemistry. The research data included mostly statements of opinions by a large number of teachers, such as: "Do you believe that beginning chemistry can be taught effectively without individual laboratory work?" Sixteen percent of the respondents said "yes" and 84 per cent said "no".[1]

There are countless other studies of the two science laboratory methods which have attempted to present conclusive results upon the greater merits of one system over the other, but none can show reliable evidence that either system will substantially increase student achievement. It is true that the real worth of a course to a student cannot be evaluated by his score; success in a large sense must be gauged this way.

According to a critique of the lecture laboratory method by Burton[2] the learner is passive and receptive; the learner is additive and associative;

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[1] Corey and Mook, "Methods of Teaching", Review of Educational Research, Volume 12.

[2] William H. Burton, The Guidance of Learning Activities (New York: Appleton-Century Co., 1944), p. 230.

the subject matter is for memorization; the procedures are static and authoritative; and the teacher assumes the role of the main participant.

J. S. Slocum, in his comparative study of lecture demonstration and laboratory method in the teaching of general science, found the following:

The lecture-demonstration method is slightly superior in teaching essential materials as outlined in the state course of study and effective as a time saver. It is less expensive than the laboratory method; and lends itself to long and difficult experimentation.[1]

Dewey B. Stuit and Max A. Englehart, in their critical summary of the lecture-demonstration versus the individual laboratory method of teaching high school chemistry, gave the following conclusions made by various investigations. These conclusions indicated that the laboratory method is superior in that:

1. There is a slight indication that material was better retained when taught by the individual laboratory method.
2. The order of preference of the methods studied places the individual laboratory method before the demonstration method.
3. For permanent learning the laboratory method is slightly superior.
4. For providing knowledge and method of attack the laboratory method is superior for the inferior student.[2]

Stuit and Englehart also reported conclusions that the lecture-demonstration is superior in that:

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[1] J. S. Slocum, "A Comparison of Lecture-Demonstration in Teaching General Science." (unpublished Master's thesis, School of Education, Louisiana State, 1936).

[2] Dewey B. Stuit and Max A. Englehart, "Critical Summary on the Lecture Demonstration Versus the Individual-Laboratory Method of Teaching High School Chemistry," Journal of Educational Research, XVIII (September, 1928), 380.

1. Bright students are more likely to profit by the lecture demonstration method than others.

2. The lecture-demonstration method takes less time and costs less.

3. Teacher demonstration is best.

4. Lecture-demonstration method gives better control over the individual since all are under teacher guidance.[1]

After considering the above conclusions, Stuit and Englehart have arrived at a few principles which seem justifiable in the light of evidence given by this study.

No method can be considered to be the best in every case. The objectives of chemistry teaching, the preference of the teacher, the nature of the pupils, and the facilities of the school will largely determine which method should be used.

In small schools where money and space are not plentiful, the lecture-demonstration method seems to be the most practicable.

The written test cannot be used to test all the outcomes of a course in high-school chemistry. Some sort of manipulative tests seem necessary to test the laboratory skills.

The problem of the relative merits of the lecture-demonstration and the individual-laboratory methods still seems involved and as complex as ever. More careful experimentation, involving careful control of non-experimental factors and reliable testing is needed in order to justify any definite and final conclusions. When experimentation has shown the relative superiorities of the methods in terms of outcomes the method should be evaluated in terms

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[1] Dewey B. Stuit and Max A. Englehart, op. cit., p. 386.

of the value attached to the outcomes.[1]

The writer feels that since there is substantial evidence that both lecture-demonstration and individual-laboratory can be contributed much, additional efforts should be made to discover ways of improving each.

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[1] Ibid.

CHAPTER II

PRESENTATION AND ANALYSIS OF DATA

Introductory Statement.--The source of the data for this study concerning the relative effectiveness of the lecture-demonstration and the individual-laboratory methods of teaching general biology were: the scores made by the forty-two students of Oxford Training School, Oxford, Mississippi on the Biology Achievement Test. The General Biology Achievement Test used in this study was composed of three forms: (a) Initial Testing, Form A, (b) Intermediate Testing, Form B, (c) Final Testing, Form C.

The data revealed by the scores on the above test made by the two groups, denoted as experimental and control, during the course of the study, will be discussed in the order enumerated above.

General Biology Achievement Test Performances.--In order to obtain the background knowledge of general biology students an initial testing period was undertaken. The data were secured from the administration of the General Biology Achievement Test, Form A, to the experimental individual laboratory group.

The tests for each group were scored, tabulated and the necessary statistical measurements such as mean, standard deviation and standard error of the mean were computed. Table 1 presents the data concerning the experimental group. Table 1 indicates a mean score of 34.60, a standard deviation of 7.02, and a standard error of the mean of 1.57.

TABLE 1

FREQUENCY DISTRIBUTION OF THE RAW SCORES OF THE EXPERIMENTAL GROUP ON THE GENERAL BIOLOGY TEST, FORM A

Class Interval	Frequency
44 - 45	1
42 - 43	3
40 - 41	3
38 - 39	1
36 - 37	2
34 - 35	3
32 - 33	3
30 - 31	0
28 - 29	1
26 - 27	1
24 - 25	1
22 - 23	1
20 - 21	0
18 - 19	1
Mean	34.60
S.D.	7.02
$S.E_m$	1.57

Table 2 reveals that a score which falls at the 95th centile indicates that a subject who obtained such a centile got less than half of the items correct.

TABLE 2

RAW SCORES AND CENTILES DERIVED FROM THE RAW SCORES OF THE EXPERIMENTAL GROUP

Raw Scores	Centiles
22	95
21	90
20	80
20	75
20	70
19	60
18	50
17	40
16	30
16	25
14	20
12	10
11	5

The data from the biology achievement test of the twenty-one students in the control group are shown in Table 3. This table reveals a mean score of 33.45, a standard deviation of 6.86, and a standard error of the mean of 1.53.

TABLE 3

FREQUENCY DISTRIBUTION OF THE RAW SCORES OF THE CONTROL GROUP ON THE GENERAL BIOLOGY TEST, FORM A

TABLE 3 - Continued

Class Interval	Frequency
42 - 43	3
40 - 41	1
38 - 39	3
36 - 37	3
34 - 35	2
32 - 33	0
30 - 31	4
28 - 29	2
26 - 27	0
24 - 25	0
22 - 23	0
20 - 21	3
Mean	33.45
S.D.	6.86
$S.E_m$	1.53

Table 4 reveals that a score which falls at the 95th centile indicates that a subject who obtained such a centile got less than half of the items correct.

TABLE 4

RAW SCORES AND CENTILES DERIVED FROM THE RAW SCORES OF THE CONTROL GROUP

TABLE 4 - Continued

Raw Scores	Centiles
23	95
22	90
21	80
21	75
20	70
19	60
17	50
16	40
15	30
15	25
14	20
11	10
10	5

Comparative Data on the Experimental and Control Groups of the Initial Test.—The data on the achievement of the twenty-one students in the experimental group and the twenty-one students in the control group are shown in Table 5, which indicates that the background knowledge in biology of the two groups is substantially the same.

From the comparison of the data in Table 5, there was no difference in the general biology knowledge of the two groups of students at the beginning of the investigation.

Table 5 reveals the "t" for these data to be .52 which is less than the size of a "t" required for reliable differences at the .05 level of confidence; therefore, there were no statistically significant differences in general biology information insofar as the two groups of students are concerned.

TABLE 5

COMPARISON OF THE EXPERIMENTAL AND CONTROL GROUPS ON THE INITIAL TEST

Groups	Mean	S.D.	$S.E_m$	M_1-M_2	$\sigma_{M_1-M_2}$	"t"
Experimental	34.60	7.02	1.57			
				1.15	2.19	.52*
Control	33.45	6.82	1.53			

*A "t" of 1.96 is required for significance at the .05 level of confidence.

To summarize and interpret, then, the non-significant "t" of .52 between the two groups indicates that the students of both of the experimental and control groups began the experiment with equal amounts of biology knowledge; therefore, any superiority in the acquisition of biology information can be attributed to the superiority of the method used.

General Biology Achievement Test Performances after the Initial Testing Period.--In order to find out to what extent the students of the two groups had profited from the use of the different instructional procedures, a second testing period was initiated. The second testing was designed to secure data that would show to what extent either method was superior to the other after nine weeks of intensive instruction. The data were secured from

the administration of the General Biology Achievement Test, Form B, which was followed by the computation of the necessary measures pertinent to the analysis and interpretation of the data.

The data on the achievement of the twenty-one students in the experimental group are shown in Table 6, which reveal a mean score of 42.21, a standard deviation of 7.66, and a standard error of the mean of 1.71.

TABLE 6

FREQUENCY DISTRIBUTION OF THE RAW SCORES OF THE EXPERIMENTAL GROUP OF THE GENERAL BIOLOGY TEST, FORM B

Class Interval	Frequency
60 - 61	1
58 - 59	0
56 - 57	0
54 - 55	0
52 - 53	0
50 - 51	3
48 - 49	1
46 - 47	3
44 - 45	2
42 - 43	1
40 - 41	3
38 - 39	0
36 - 37	1

TABLE 6 - Continued

Class Interval	Frequency
34 - 35	3
32 - 33	1
30 - 31	2
Mean	42.21
S.D.	7.66
$S.E_m$	1.71

Table 7 reveals that a score which falls at the 95th centile indicates that a subject who obtains such a centile got little more than half of the items correct.

TABLE 7

RAW SCORES AND CENTILES DERIVED FROM THE RAW SCORES OF THE EXPERIMENTAL GROUP

Raw Scores	Centiles
29	95
26	90
25	80
24	75
24	70
23	60
22	50
20	40
19	30
18	25
17	20
16	10
16	5

The data on the achievement of the twenty-one students in the control groups are shown in Table 8, which reveal a mean score of 38.21, a standard deviation of 4.72, and a standard error of the mean of 1.06.

TABLE 8

FREQUENCY DISTRIBUTION OF THE RAW SCORES OF THE CONTROL GROUP ON THE GENERAL BIOLOGY TEST, FORM B

Class Interval	Frequency
46 - 47	1
44 - 45	3
42 - 43	2
40 - 41	3
38 - 39	2
36 - 37	3
34 - 35	2
32 - 33	4
30 - 31	1
Mean	38.21
S.D.	4.72
$S.E_m$	1.06

Table 9 reveals that a score which falls at the 95th centile indicates that a subject who obtained such a centile got less than half of the items correct.

TABLE 9

RAW SCORES AND CENTILES DERIVED FROM THE RAW SCORES OF THE CONTROL GROUP

Raw Scores	Centile
24	95
23	90
22	80
21	75
20	70
19	60
19	50
18	40
17	30
16	25
16	20
	10
	5

Comparative data on the Experimental and Control Groups of the Intermediate Test.--The data on the achievement of the twenty-one students in the experimental and control groups are show in Table 10. The table also reveals that after nine weeks of systematic instruction the experimental group using the "individual" laboratory method showed gains in the acquisition of general biology information over the control group using the lecture-demonstration.

The experimental group showed the higher mean score of 42.31 which was 4 points above the mean score of 38.21 of the control group. The experimental group showed the larger sigma of 4.72 of the control. The close similarity of the two groups in terms of their standard error of the mean of 1.06 was shown in the difference of 6 points between the standard error of 1.71 for the experimental group and the standard error of the mean of 1.06 for the control group.

From the comparison of the data from Tables 6, 8, and 10, it would not appear logical to assume that there was no significant difference in the gains in general biology information by the students taught by the lecture-demonstration and those taught by the individual laboratory method. The individual laboratory method showed greater effectiveness in terms of actual student achievement.

TABLE 10

COMPARISON OF EXPERIMENTAL AND CONTROL GROUPS ON THE INTERMEDIATE TEST

Group	Mean	S.D.	$S.E_m$	M_3-M_4	$\sigma_{M_3-M_4}$	"t"
Experimental	42.21	7.66	1.71			
				4.00	2.01	1.99
Control	38.21	4.72	1.06			

Table 10 reveals the "t" for the data to be 1.99 which was more than 1.96 at the .05 level of confidence, and therefore indicated that between the two groups of students there was a statistically significant difference

in the "gains" in the general biology information during the nine weeks.

To summarize and interpret, the significant "t" ratio of 1.99 between the two groups indicates that the experimental group showed superiority in terms of actual achievement over the control group.

General Biology Achievement Test of Performance.--The rotation method of experimentation designed for this study made it necessary that during the second nine weeks period of study the two groups would exchange the use of instructional methods; therefore, during the period of the tenth through the eighteenth week of study the previous experimental group was taught by the lecture-demonstration method and the previous control group was taught by the individual laboratory method.

During the second nine weeks period, the original control group became the experimental group. Again, the identical learning materials were taught to each group.

At the end of the second nine weeks period, that is, at the end of the eighteenth week which marked the close of the entire experimental period of study, the final General Biology Achievement Test, Form C, was administered and was followed up with the computation of the necessary statistical measures basic to the analysis and interpretation of the data gathered from the test.

The data on the achievement of the twenty-one students in the experimental group are shown in Table 11, which reveal a mean score of 50.71, a standard deviation of 11.76, and a standard error of the mean of 2.63.

TABLE 11

FREQUENCY DISTRIBUTION OF THE RAW SCORES OF THE EXPERIMENTAL GROUP ON GENERAL BIOLOGY TEST, FORM C

TABLE 11 - Continued

Class Interval	Frequency
69 - 71	1
66 - 68	4
63 - 65	1
60 - 62	1
57 - 59	0
54 - 56	0
51 - 53	0
48 - 50	3
45 - 47	3
42 - 44	4
39 - 41	1
36 - 38	2
33 - 35	0
30 - 32	1

Mean	50.71
S.D.	11.76
$S.E_m$	2.63

Table 12 reveals that a score which falls at the 95th centile indicates that a subject who obtains such a centile got more than half of the items correct.

TABLE 12

RAW SCORES AND THE CENTILES DERIVED FROM THE RAW SCORES OF THE EXPERIMENTAL GROUP

Raw Scores	Centiles
36	95
34	90
33	80
32	75
31	70
25	60
24	50
23	40
22	30
21	25
21	20
19	10
18	5

The data on the achievement of the twenty-one students in the control group are shown in Table 13, which reveal a mean score of 45.72, a standard deviation of 10.38, and a standard error of the mean of 2.32.

TABLE 13

FREQUENCY DISTRIBUTION OF THE RAW SCORES OF THE CONTROL GROUP ON THE GENERAL BIOLOGY TEST, FORM C

TABLE 13 - Continued

Class Interval	Frequency
63 - 65	1
60 - 62	1
57 - 59	1
54 - 56	3
51 - 53	1
48 - 50	4
45 - 47	1
42 - 44	2
39 - 41	1
36 - 38	1
33 - 35	0
30 - 32	5
Mean	45.72
S.D.	10.38
$S.E_m$	2.32

Table 14 reveals that a score which falls at the 95th centile indicates that a subject who obtained such a centile got more than half of the items correct.

TABLE 14

RAW SCORES AND CENTILES DERIVED FROM THE RAW SCORES OF THE CONTROL GROUP

TABLE 14 - Continued

Raw Scores	Centiles
31	95
29	90
28	80
27	75
26	70
25	60
24	50
22	40
20	30
18	25
16	20
16	10
15	5

Comparative Data on the Experimental and Control Groups of the Final Test.--The data on the achievement of the twenty-one students in the experimental group and the twenty-one students in the control group are shown in Table 15, which reveal that after eighteen weeks of systematic instruction the experimental group which was taught by the lecture-demonstration method showed a significant gain in the acquisition of general biology information.

The experimental group showed the higher mean score of 50.71 which was 4.99 points above the mean score of 45.72 of the control group. The experimental group showed the larger sigma of 11.76 which was 1.38 points above

the sigma of 10.38 of the control. The close similarity of the two groups in terms of their standard error of the mean was shown in the difference of .31 between the standard error of 2.63 for the experimental group, and the standard error of the mean of 2.32 for the control group.

Table 15 shows the "t" ratio for the data to be 1.42 which was less than 1.96 at the .05 level of confidence; therefore, there were no statistically significant differences in general biology information insofar as the two groups of students are concerned.

TABLE 15

COMPARISON OF EXPERIMENTAL AND CONTROL GROUPS ON THE FINAL TEST

Groups	Mean	S.D.	$S.E_m$	M_5-M_6	$\sigma_{M_5-M_6}$	"t"
Experimental	50.71	11.76	2.63			
				4.99	3.51	1.42
Control	45.72	10.38	2.32			

Comparison of Biology Knowledge of Experimental and Control Groups by Mean Differences.--Table 16 reveals the difference between M_1 and M_2 to be 7.61 and the "t" ratio for the data to be 3.28 which was more than 1.96 at the .05 level of confidence. This indicates that the experimental method was more effective than the control method.

TABLE 16

SIGNIFICANCE OF DIFFERENCE BETWEEN M_1 and M_3

TABLE 16-Continued

Test	Mean	S.D.	$S.E_m$	M_1-M_3	$\sigma_{M_1-M_3}$	"t"
Initial	34.60	7.02	1.57			
				7.61	2.32	3.28
Intermediate	42.21	7.66	1.71			

Table 17 reveals the difference between M_4 and M_5 to be 12.50 and the "t" ratio for the data to be 4.40 which was more than 1.96 at the .05 level of confidence. Again the experimental method of teaching was found to be more effective than the control method.

TABLE 17

SIGNIFICANCE OF THE DIFFERENCE BETWEEN M_4 AND M_5

Test	Mean	S.D.	$S.E_m$	$M_4 - M_5$	$\sigma_{M_4-M_5}$	"t"
Intermediate	38.21	4.72	1.06			
				12.50	2.84	4.40
Final	50.71	11.76	2.63			

Table 18 reveals the difference between M_5 and M_6 to be 3.51 and the "t" ratio for the data to be 1.22 which was less than 1.96 at the level of confidence.

TABLE 18

SIGNIFICANCE OF THE DIFFERENCE BETWEEN M_3 AND M_6

Test	Mean	S.D.	$S.E_m$	M_3-M_6	$\sigma_{M_3 - M_6}$	"t"
Intermediate	42.21	7.66	1.71			
				3.51	2.88	1.22
Final	45.72	10.38	2.32			

Table 19 reveals the difference between M_2 and M_4 to be 4.76 and the "t" ratio for the data to be 1.55 which was less than 1.96 at the level of confidence.

TABLE 19

SIGNIFICANCE OF THE DIFFERENCE BETWEEN M_2 AND M_4

Test	Mean	S.D.	$S.E_m$	M_2-M_4	$\sigma_{M_2-M_4}$	"t"
Initial	33.45	6.86	1.53			
				4.76	3.08	1.55
Intermediate	38.21	4.72	1.06			

The null hypothesis that there is no difference in the relative effectiveness of the two methods of teaching biology was rejected since the experimental group before and after rotation manifested higher degrees of

biology knowledge than did the control group. It can be concluded that the individual laboratory method of teaching biology to the tenth grade subjects of the present study was relatively more effective than the lecture-demonstration method.

CHAPTER III

SUMMARY, CONCLUSION, IMPLICATIONS AND RECOMMENDATIONS

Problem and Methodology.--The problem of this investigation was to determine the relative effectiveness of two methods of classroom instruction, the individual laboratory and the lecture demonstration methods, when they were used in the teaching of general biology to forty-two tenth grade students at Oxford Training School, Oxford, Mississippi.

The specific purpose of the study was to test, by experimentation, the following null hypothesis: There is no difference in the relative effectiveness of the methods, individual laboratory and lecture demonstration, as determined by the criterion of achievement or standardized tests.

This study was limited in that it was confined to the total enrollment of the Oxford Training High School, Oxford, Mississippi. The data were collected during the school year, 1959-1960.

The research utilized the experimental method with the rotation group technique to collect the data and statistical techniques to interpret the collected data.

The instrument used in this study was a teacher made biology test. The test items were selected from "Questions and Problems in Science" (Test Items Folio No. 1 - Paul L. Dressel and Clarence H. Nelson, Ed.).

The data obtained from the teacher made biology test were presented and interpreted in appropriate tables and explanations which appear in Chapter II of this thesis.

The procedural steps used for conducting this study were as follows:

1. Permission to conduct the study was requested from the proper school officials.
2. Literature pertinent to this study was reviewed, summarized and is presented in this chapter.
3. The pupils who served as subjects in this study were oriented as to the nature, scope and purpose of this research. These groups were not equated. The two groups as listed in the school's schedule were used.
4. The rotation group method was used as the experimental design.
5. The data derived from this study were treated statistically and in turn assembled in appropriate tables.
6. The findings, conclusions, implications and recommendations derived from the present study are presented in the third chapter of the thesis.

Summary of Related Literature.--The pertinent literature under three captions, namely: research concerning teaching biology by the individual laboratory method, research concerning teaching biology by the lecture demonstration method and research concerning the teaching of science.

Neither one of the methods, individual laboratory nor lecture demonstration is wholly wrong and the other wholly correct. Each has a place and a function.

Certain investigators believed that the learning process proceeds more effectively under that type of teaching which guides and stimulates without dominating or coercing other investigators believed that the learning proceeds more effectively under that type of teaching that is thorough and exact.

There were some investigators who emphasized that because of the heterogeneity of the students, the increase in the number of the students, and the lack of facilities, newer methods and techniques should be applied. They further indicated that the objectives of the subject taught, the preferences of the teacher, the nature of the learner, and the changing civilization will largely determine which method should be used.

Summary of Findings.--In order to give an overall view of the findings, a recapitulation of the results of the testing made during the period of this study is presented in Table 20, which shows the pertinent data basic to the analysis and interpretation of the findings covering the entire period of the experimentation.

TABLE 20

THE MEAN SCORE, STANDARD DEVIATIONS, STANDARD ERRORS OF THE MEANS, DIFFERENCES BETWEEN THE MEANS, STANDARD ERRORS OF THE DIFFERENCES OF THE MEANS, AND THE "t" RATIOS OF THE EXPERIMENTAL AND CONTROL GROUPS ON THE INITIAL, INTERMEDIATE AND FINAL TEST OF GENERAL BIOLOGY, FORM A, B, AND C.

Test	Initial		Intermediate		Final	
Group	Experimental	Control	Experimental	Control	Experimental	Control
Number	21	21	21	21	21	21
Mean	34.60	33.45	42.21	38.21	50.71	45.72
S.D.	7.02	6.86	7.66	4.72	11.76	10.38
$S.E_m$	1.57	1.53	1.71	1.06	2.63	2.32
M - M	1.15		4.00		4.99	
σ_{M-M}	2.19		2.01		3.51	
"t"	.52		1.99		1.42	

The findings derived from a careful analysis and interpretation of the experimental data are as follows:

1. On the initial and final forms of the General Biology Achievement Test, the "t" ratios of .52 and 1.42 which were less than 1.96 at the .05 level of confidence and therefore indicated that there were no significant difference between the two groups. On the intermediate biology test, the "t" ratios of 1.99 was significant because it was more than 1.96 at the .05 level of confidence.
2. The "t" ratios of the mean differences of the experimental groups before and after rotation were 3.28 and 4.40 which is indicative that the null hypothesis was rejected. It can be concluded that the individual laboratory method of teaching to the tenth grade subjects of the present study was relatively more effective than lecture demonstration method.

Conclusion.--The conclusion based upon the gathering, analyzing and interpreting of the data on the two groups of biology students to test the relative effectiveness of the methods, individual laboratory and lecture demonstration, would say that the null hypothesis is rejected.

Implications.--The implications that can be drawn from the study are:

1. The subjects in the experimental group and the control group showed a very low degree of biology knowledge.
2. There should be more research designed to ascertain more effective means of increasing the knowledge of biology for secondary students.

Recommendations.--The following recommendations should be followed in future studies in this field:

1. The experiment should be carried on jointly by many schools using identical programs of methods. In this way, any results obtained would be based upon composite results of many and varied communities and thus would finally offer a more definite answer as to which is the superior type of teaching method for General Biology.
2. Methods of increasing biology knowledge of the students should be discovered. The writer giving weekly tests which measure the biology achievement would reveal weaknesses of the subjects. Item analysis of each test would also reveal questions missed more. Remedial work should follow each item analysis.

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APPENDIXES

FORM A

1. The production of a new useful material by cells is called

   A. digestion B. secretion C. induction D. agglutination

2. Cellulose is found in the cell walls of

   A. all plants B. higher plants C. all animals D. plants and animals

3. A mass of protoplasm that is a unit of structure, function and development is called

   A. an organ B. a tissue C. a plastid D. a virus E. a cell.

4. Of the following the one which is found in the highest percentage in the protoplasm of a typical cell under typical conditions is

   A. protein B. carbohydrate C. water D. mineral matter E. fat.

5. In plant cell, a pigment important in the manufacture of carbohydrates from carbon dioxide and water is contained in the

   A. nucleus B. cytoplasm C. centrosome D. vacuole E. chloroplast.

6. The plant cell is chemically composed chiefly of

   A. carbohydrates B. steriods C. fats and other lipids D. proteins E. a complex of lipids and proteins.

7. If you were looking at some cells through a microscope they could be identified as animal cells if they contained

   A. nuclei B. chromosomes C. vacuoles D. chloroplast E. no cell wall.

8. Four of the following are generally common to both plants and animals cells. Which one is not?

   A. cell wall B. cell membrane C. nucleus D. cytoplasm E. vacuole

9. Of the following characteristics, which one is common to all living cells?

A. cellulose cell wall B. nuclear material scattered throughout the cell C. cell membrane D. chloroplasts E. more than one of the above.

10. The process whereby water, carbon dioxide, and light energy are combined through the acid of chlorophyll to produce carbohydrate food is

A. photosyntheses B. photochemistry C. transpiration D. phototropism E. respiration.

11. Photosynthesis is a chemical process by which plants form

A. starch B. sugar C. sugar from starch D. chlorophyll E. starch and chlorophyll.

12. Chloroplasts

A. function in photosynthesis

B. function in respiration

C. store food

D. are located in the nucleus

E. are found in all plant cells

13. The energy the green plants use in making food usually come from

A. the soil B. sunlight C. the plant roots D. water E. oxygen in the air.

14. The rate of photosynthesis may depend on the amount of

A. moisture in the air B. boron in the air C. carbon dioxide in the air D. carbon dioxide in the soil E. all of these

Items 15 - 19 place of action

A. large intestine B. liver C. mouth D. small intestine E. stomach

Where do the following enzymes act?

15. Amylopsin

16. Pepsin

17. Erepsin

18. Ptyalin

19. Rennin

20. The capillaries

A. Only carry blood free of all carbon dioxide,

B. Only carry blood free of all oxygen,

C. Connect arteries and veins,

D. are tiny arteries,

E. are tiny veins.

21. Oxygen is carried in the blood by the

A. lymph B. erythrocytes C. fibrin D. phagocytes E. phatelets

22. The bulk of material comprising blood plasma is probably

A. hemoglobin B. fibrinogen C. the antibody complement D. water

E. the hormone complement.

23. Gases diffuse into and out of the blood

A. in the arteries B. in the veins C. in the heart D. in the lymphatics E. in the capillaries.

24. Hemoglobin is most closely associated with

A. blood clotting B. hormone formation C. oxygen transport

D. food transport E. lymph transport.

25. Urea is mainly excreted from the body by

A. skin B. lungs C. kidney D. liver

26. The elimination of metabolic wastes from the body is called

A. egestion B. oxidation C. assimilation D. excretion.

27. The elimination of undigested materials from the body is known as

A. digestion B. excretion C. reproduction D. reaction to stimuli E. support and movement.

28. The glomeruli are most closely related to the system involved in

A. digestion B. excretion C. reproduction D. reaction to stimuli E. support and movement.

29. Glucose is excreted from the blood when above which of the following concentrations?

A. 0.05% B. 0.1% C. 0.14% D. 0.10%

30. A dendrite is a part of

A. a bone cell B. a nerve cell C. striated muscle cell D. A connective tissue cell E. an epithelial cell

31. The many small branches of a nerve cell are called

A. ganglia B. dendrites C. flagella D. synapses E. neurons

32. An individual nerve cell:

A. axon B. dendrite C. neuron D. neurilemma E. myelin sheath

33. Which of the following hormones enables the body to store and oxidize sugar

A. insulin B. adrenalin C. secretion D. pituitrin E. the elin

34. The islet cells of the pancreas secrete the substance

A. secretin B. cholecystokinin C. lipase D. protease E. insulin

35. The chief factor in the production of black or humus soil is the action of

A. running water B. differential erosion C. bacteria or organic

material D. cultivation and grazying E. ground water.

36. Frogs and toads are

A. key industry animals B. herbivores C. saprophytes D. ecologial equivalents E. scavengers

37. Vultures are

A. herbivores B. green plants C. carnivores D. scavengers E. saprophytes

38. Mosses are

A. herbivores B. green plants C. carnivores D. scavengers E. saprophytes

39. Bobcats are

A. herbivores B. key industry animals C. carnivores D. scavengers E. saprophytes.

40. A life-community is made up of the following groups:

A. insectivores B. carnivores C. scavengers D. green plants E. saprophytes.

41. Bread mold is

A. a symbiont B. scavenger C. an ecological equivalent D. a saprophyte E. an herbivore.

42. Nodule bacteria are

A. symbiont B. scavenger C. herbivores D. saprophytes E. parasites.

43. Wheat rust is

A. symbionts B. a scavenger C. an herbivore D. a saprophyte E. a parasite

44. Foods are spoiled by

A. symbionts B. scavengers C. herbivores D. saprophytes

E. a parasite

45. In meiosis, for every primary spermatocyte, the number of sperms produced is

A. one B. two C. four D. eight E. dependent on the species

46. Meiosis is important because

A. it halves the chromosome number

B. it requires two steps

C. it produces daughter cell

D. Most cells divide mitotically

E. most growth occurs this way

47. What is ovulation?

A. the production of eggs in the follicle

B. the surgical removal of a diseased ovary

C. the implication of a futilzed egg in the ovary

D. the escape of a mature egg from the follicle

E. none of the above.

48. At some period in their development all mammals are covered with

A. hair B. feathers C. spiracle D. scales E. Mammary glands

49. A group which characteristically reproduces by internal fertilization is the

A. fish B. shell fish C. amphibians D. protozoa E. insects.

50. Which of the following is the outer germ lay or cell layer of an early embryo?

A. Ectoderm B. Ectoplasm C. Endoplasm D. Entoderm E. mesoderm.

FORM B

1. The membrane on the surface of the cytoplasm is called

   A. plasmodesma B. vacuole membrane C. middle lanella D. plasma membrane E. cytosme.

2. The cell theory was states as an hypothesis by

   A. Schleiden and Schwann B. Leeuwenhoek C. Malpighi D. Hooke E. LaPlase

3. The characteristic of protoplasm to construct new protoplasm from single materials, to oxidize food materials and to break down living matter is referred to by the general term

   A. anabolism B. osmosis C. catabolism D. metabolism E. symbiosis

4. The portion of the protoplasm which is chiefly responsible for coordinating and controlling the chemical and physical changes which result in the production of more protoplasm is the

   A. nucleus B. plasma membrane C. cytoplasm D. chloroplast E. cell wall.

5. The portion of the protoplasm in which most of the energy-releasing chemical changes occur in a cell is the

   A. nucleus B. plasma membrane C. cytoplasm D. chloroplast E. vacuole.

6. Which of the following represents the smallest groups of substances that includes both the material from which the plant cell wall is made and simple sugar?

   A. organic substance B. cellulose C. starch D. double sugar E. carbohydrates.

7. A structural component of cells which can be demonstrated, but not seen with the ordinary microscope, is the

   A. nucleus B. chromosome C. plasma membrane D. chloroplast E. nucleulus.

8. Which of the following forms the boundary of an animal cell?

   A. nucleus B. centricle C. mitochondria D. plasma membrane

9. If you were looking at some cells through a microscope, they could definitely be identified as plant cells and not animal cells if they had

   A. nuclei B. chromosomes C. vacuole D. cell membrane E. cell walls.

10. True - False 10-14

    Chlorophyll is the oxygen-carrying pigment of red blood cells.

11. The most useful function of chlorophyll may be that of a pigment.

12. The bulk of matter is green leaves on a growing plant consists of nitrogen.

13. Respiration contribute carbon dioxide to the atmosphere.

14. The special function of the green cells of a plant is the secretion of suxius.

15. Bile is secreted by the

    A. pancreas B. kidney C. unriniferous tabules D. small intestine E. liver.

16. Scurvey may be a result of deficiency in vitamin

    A. a B. b C. c D. d E. e

17. The characteristic of the protoplasm to construct new protoplasm from simple materials and to break down living matter is referred to by the general term

A. anabolism B. osmosis C. catabolism D. metabolism E. symbiosis

18. Metabolism is

A. energy releasing activity in a cell

B. reproduction of a cell

C. growth of a cell

D. exchange of materials in a cell

E. the total of all chemical and physical changes occurring in protoplasm.

19. The following enzymes are found in the pancreas

A. pepsin B. lipase C. sucrase E. lactase

20. A human white blood corpuscle

A. contains oxyhemoglobin B. has no nucleus C. is formed in the liver D. larger than a human red blood cell.

21. Arteries may be defined as vessels carrying

A. "impure" blood B. blood away from the heart C. "pure" blood D. blood toward the heart.

22. The human heart is inclosed in a membraneous sac called the

A. peritoneum B. pleural sac C. periosteum D. pericardium

23. The upper chambers of the human heart are called

A. vena cavae B. ventricles C. auricles D. pleural.

24. A strong vertical septum separates the right ventricle from the

A. right auricle B. aorta C. left ventricle D. tricuspid valve E. semilunar valve.

25. The organ within which the proportions of the inorganic salts in the blood is regulated is the

A. kidney B. liver C. parathyroid D. adrenal cortex E. wall of the small intestine

26. It is believed that contractile vacuoles serve mainly to

A. discharge nitrogenous waste B. digest food C. transport non-digestible materials in an anal pore D. regulate water content E. aid respiration, mainly by discharge of CO2.

27. Which one of the following would not be considered a metabolus waste product in plants?

A. Anthocyanin B. Renins C Gums D. Essential oils E. Glucose

28. The most important function of perspiration is to

A. get rid of body poisons

B. regulate the body water supply

C. regulate the body temperature

D. keep the pores clear of dirt

E. lubricate the epithelial cells

29. Which of these is the first to break the proper sequence?

A. kidney B. uretha C. bladder D. ureter E. none of these

30. An invariable response toward or away from a stimilus:

A. habit B. tropism C. reflex D. instinct E. synapse

31. A group of nerve cell bodies and their connections:

A synapse B. plasmodesmate C. choroid D. dendrone E. ganglion

32. A nervous system composed of cranial and sprial nerves:

A. peripheral B. autonomic C. central D. branchial E. gray matter.

33. A hormone that affects the body "use of sugar":

A. insulin B. estrogen C. pepsin D. amylopsin E. prothrombin

34. (True or false) Cretinism is a disease characterized by mental and physical retardation caused by a thyroid deficiency.

35. The body of coelenterates is made up of two cell layers

A. epidermis and submucosa

B. ectoderm and endoderm

C. ectoplasm and endoplasm

D. cilia and pseudopodia

E. protoplasm and cytoplasm

36. Artifical parthenogenesis is ordinarily accomplished by the physical or chemical stimulation of

A. a zygote B. a spermatozoan C. an unfertilized ovum D. an unbranched hydra E. a fertilized egg.

37. The garter snake gives birth to living young. This species of snake would be characterized as

A. viviparous B. ovoviviparious C. oviparous D. placental

D. precocial.

38. In multicellular animals the term somatic is applied to all cells except the

A. male gamete B. female gametes C. germ cells and their primordia of both sexes D. cells of the brain and nervous system E. cell comprising the auriculd-ventriculas node in the heart.

39. Parthenogenesis occurs when an embryo develops from

A. a zygote B. a zygospore C. an unfertilized egg D. an antheridium E. a zoospore.

40. A seed is most adequately described as a (an)

A. matured ovary B. matured ovule C. egg which has undergone development D. zygote E. fruit.

41. Food is supplied to the embryo of man by the

A. amnion B. coelom C. allantois D. pancreas E. placenta.

42. The type of reproduction most characteristic of land inhabiting vertebrates is

A. internal fertilization B. budding C. external D. binary fission E. none of the above.

43. Nitrogen from the air is added to the soil by

A. symbionts B. scavengers C. herbivores D. saprophytes E. parasites.

44. Symbiosis is represented by an association such as that involving

A. tapeworm and man. B. leather and mildew C. malaria organism and man.

45. The relationship between the two plants which constitute a lechen is known as

A. Parasitism B. saprophytism C. symbiosis D. synthesis E. homology.

46. The disposal of sewage in a septic tank is accomplished mainly by the action of

A. bacteriophage B. viruses C. protozoa D. bacteria E. rickettsias.

47. Of the following zones of vegetation, the one found at the highest altitude is

A. coniferous forests B. low herbs and shrubs C. mosses and lechens D. deciduous forests E. palms and orchids.

48. The branch of biology dealing with the relationship between organisms and their environment is termed

A. cytology B. limnology C. ecology D. histology E. pathology

49. The union of a sperm and egg

A. restores the haploid number of chromosomes

B. is known as insemination

C. can only initiate cleavage

D. gives rise to a zygote

E. is copulation

50. Of the following the part not included in the pistil is the

A. stigma B. style C. anther D. ovule E. ovary

FORM C

1. A mass of protoplasm that is a unit of structure, function, and development is called

   A. an organ B. a tissue C. a plastid D. a virus E. a cell

2. Animal and plant cells are similar in all except which one of the following characteristics?

   A. nucleus B. cytoplasm C. nucleos membrane D. cell membrane

   E. cell wall

3. The statement "The cell is the unit of structure, function, and reproduction of the living organism" represents the

   A. organismal concept B. definition of a cell C. protoplasmic concept D. species concept E. cell principle.

4. Which one of the following is characteristic of the elodea cell but not of a cheek living cell?

   A. nucleus B. cytoplasm C. cell wall D. cell membrane E. protoplasm

5. The secreted non-living, outer covering of the cells of plants is the

   A. plasma membrane B. cytoplasm C. chloroplast D. cell wall

   E. centrosome.

6. The term "differentially permeable" is used to describe which of the following parts or constituents of a typical living cell?

   A. nucleus B. cytoplasm C. centrosome D. plasma membrane

   E. chromatin net.

7. The part of the cell which contains materials of use to the cell or which functions in the process of elimination is the

   A. nucleus B. plasma membrane C. vacuole D. chloroplast E. centrosome.

9. A cell which is 25 microns in diameter is

A. larger than B. smaller than C. approximately the same size as a similar cell which is 1/2500 inch in diameter.

10. The grestest number of green cells are found in higher plants chiefly

A. on the upper surface of leaves

B. in the epidermis exposed to air

C. on the lower surface of leaves

D. along the ribs on leaves

E. beneath the upper epidermis of leaves.

11. Chloroplast are

A. one of the zones of a leaf

B. a group of the green algae

C. erthrocytes

D. members of the protista

E. formed bodies in plant cytoplasm containing chlorophyll

12. The green pitment, chlorophyll, is found in

A. the vacuole of a leaf cell

B. the nucleus of a leaf cell

C. the plastide of leaf cells

D. the cells sap of leaves

E. the stomata of leaves

13. An end product of photosynthesis is

A. glucose is a by-product B. starche is a by-product

C. water is a by-product D. oxygen is a by-product

E. carbon dioxide is a by-product

14. In photosynthesis

A. glucose is a by-product B. starche is a by-product C. water is a by-product D. oxygen is a by-product E. carbon dioxide is a by-product.

15. The following secretion aids in the difestion of fats

A. bile B. trypsin C. pepsin C. enterokinase

16. Lack of iodine is often related to which of the following diseases?

A. Beriberi B. Scurvy C. Rickets D. Thyroid disease

17. An end product of fat digestion is

A. glycogen B. yalactose C. glucose D. glycerol E. fructose

18. The water content of a normal man is approximately

A. 10% B. 25% C. 60% to 65% D. 95%

19. Food is moved along through the intestine by a wavelike motion known as

A. iscillation B. fluctuation C. permutation D. permeation E. peristalsis.

20. Blood leaves the left ventricle by way of the blood vessel called the

A. pulmonary artery B. pulmonary vein C. aorta D. vena cava

21. In the human, the chamber with the thickest wall is the

A. left ventricle B. right ventricle C. left auricle D. right auricle

22. Blood returns from the lungs to

A. left ventricle B. right ventricle C. right auricle D. left auricle.

23. The blood vessels equipped with the most valves are the

A. arteries B. veins C. capillaries D. arteriole E. venules

24. The liquid formed when blood clots is called

A. plasma B. lymph C. serum D. whole blood E. water

25. Which of the following organs do not excrete salts?

A. lungs B. kidneys C. sweat glands D. none of the above

26. The human urinary system does not include the

A. renal unit B. glomerulus C. uretha D. graafian follicle E. ureter.

27. As urine passes through the ureters, bladder or uretha

A. no change occurs in the urine

B. urea is reabsorbed

C. water is absorbed

D. additional nitrogenous waste products are added

28. Which one of the following includes or contains all the others?

A. renal unit B. kidney C. glomerulus D. glomerular capsule E. renal tuble.

29. One of the waste products of protein metabolism is

A. pepsinogen B. trypsin C. amino acid D. urea E. urine.

30. A secretion from a nerve ending:

A. thyroxin B. insulin C. sympathin D. secretion E. adrenalin

31. Sensitivity or initiability is found only in

A. animals B. plants C. animals with a nervous system D. sense organs E. living protoplasm.

32. The part of the brain directly associated with the learning process is the

A. cerebellum B. pons C. cerebrum D. mid-brain E. medulla

33. Glands that produce a hormone functioning in calcium metabolism:

A. thyroids B. adrenals C. isles of langerhans D. gonads
E. parathyroids

34. The pituitary gland is an

A. endocrine gland B. exocrine gland C. duct-gland D. unicellular gland

35. Ecology is

A. the study of evolution

B. the study of fossils

C. the study of disease

D. The study of relation of animals to the environment

E. none of the above

36. Which of the following is not an essential constitutent of productive agricultural soil?

A. air B. nitrogen C. chlorine D. water E. bacteria

37. Orderly change in animal and plant species occupying the same habitate are termed

A. successions B. migrations C. zonations D. aggregations

38. Higher plants generally abosrb nitrogen from the soil in the form of

A. nitrogen mole cules B. urea C. nitrates D. proteins
E. amino acids

39. An inclusive natural habitate of wide geographic range that is made up of characteristic fauna and flora is the

A. environment B. zone C. community D. biome.

40. An ecological series that displays orderly changes of the biotic constitution in a habitat exemplifies

A. succession B. biome C. environment D. climax

41. Which of the following practices would not help to conserve soil?

A. strip cropping B. planting of crops in horizontal rows around a slope C. terracing D. planting crops in rows running up a slope

42. In the ocean depths, the most important factor that limits plant life is

A. light B. salts carbon dioxide D. none of the above

43. The fusion of two chromosomes in meiosis is called

A. synapse B. synapsis C. reduction division D. mitotic division E. telaphase.

44. One of the following is not a phase of mitosis

A. prophase B. mesophase C. metaphase D. anaphase E. telaphase

45. An organ of nourishment common to mother and baby is the

A. blastula B. placenta C. uterus D. notochord E. blood.

46. A hollow ball stage in embryo development:

A. blastula B. gastrula C. morula D. endoderm E. mesoderm.

47. The outer layer of embryonic tissue:

A. mesoderm B. endoderm C. ectoderm D. archenteron E. blastocoele

48. A hermaphroditic animal usually reproduces by

A. self-fertilization B. parthenogenesis C. cross-fertilization D. asexual method E. none of the above methods.

49. Which of the following scientists developed a means of preventing rabies

A. Linnaeus B. Pasteur C. DeVries D. Samarck E. Weismann.

50. An example of a deficiency disease is

A. trichinosis B. smallpox C. common cold D. tapeworm infection E. scurvy.